A Sure Bet

Three New Initiatives Move Into the Winner's Circle at Ames Laboratory

by Steve Karsjen

(left to right) Gary Osweiler explains the ISU Veterinary Diagnostic Laboratory's new quick-response bioterrorism database to U.S. Rep. Tom Latham and ISU President Gregory Geoffroy. Congressman Latham had just announced funding for the MFRC and BRC initiatives.

In horse racing, a trifecta is achieved by picking three winners in a row. Ames Laboratory hopes to achieve its own trifecta of sorts in three new initiatives – one in forensics, one in biorenewables and a third in catalysis. And all bets are on a successful outcome.

Midwest Forensics Resource Center

Moving with breakneck speed would be the best way to characterize the pace of activities associated with Ames Laboratory's Midwest Forensics Resource Center, or MFRC. First, there were goals to write and rewrite in order to establish the MFRC at the Lab and Iowa State University. Then there was the rural law enforcement workshop to plan and hold, which was followed by the annual crime laboratory directors' meeting, which included an add-on meeting to discuss preparedness for agro-bio-emergencies. At the same time these projects were being undertaken, David Baldwin, director of the MFRC and Ames Lab program director of Environmental and Protection Sciences, was assembling the draft of the research "call for proposals" for projects to be funded through the MFRC. Successful proposals will receive approximately $55,000 in one-year funding. Final approval of the draft comes next, followed by funding of selected research proposals. All in all, it's been an exhaustive first phase for this Ames Laboratory initiative, but according to Baldwin, the pace was necessary for the MFRC to position itself to meet the growing demand for forensic analyses in areas ranging from counter-terrorism to crime-scene and DNA analysis. "We've tried very hard to be on the edge and ready to go," says Baldwin. "We simply don't want to lose our audience at this point."

This audience of MFRC collaborators includes several high-level government agencies, including the Bureau of Alcohol, Tobacco and Firearms; the FBI; the Department of Justice's National Institute of Justice; the National Terrorism Preparedness Institute; and the Department of Energy. In addition, the MFRC is partnering with crime lab officials from nine Midwestern states, including North Dakota, South Dakota, Nebraska, Kansas, Missouri, Wisconsin, Minnesota, Iowa, and more recently Illinois. Other partners include Iowa State University and ISU's Institute for Physical Research and Technology.

The MFRC got a major boost in January 2002 when U.S. Rep. Tom Latham announced financial support for the center. The $3 million in federal funding was the successful ending to a long story for Ames Lab Director Tom Barton, who years earlier had begun discussing establishing the MFRC with Randy Murch, then deputy director of the FBI Laboratory. Those conversations were held in the cafeteria of the J. Edgar Hoover building in Washington, D.C. "We talked about the problems facing the nation's crime labs – needs and obstacles," says Barton, "and how Ames Lab and Iowa State University could partner to solve them."

Those early discussions eventually led to a variety of research projects being funded by the FBI. Projects ranged from a type of quick-response bioterrorism database (a joint venture between the Ames Lab and ISU's Veterinary Diagnostic Laboratory) that includes information for labs on veterinary response to livestock pathogens to a fingerprint chamber, or glove box, that detects latent fingerprints on things like cans, guns, even plastic bags. The very first glove box is housed in the Iowa Division of Criminal Investigation's Criminalistics Laboratory in Des Moines, Iowa. A second glove box is being used by experts in the crime lab of the Story County Sheriff's Department in Nevada, Iowa. Rural law-enforcement agencies with limited budgets, such as the one in Story County, are considered prime benefactors of the research expertise developed by MFRC scientists says a grateful Story County Sheriff Paul Fitzgerald. "The glove box is certainly something that's going to advance our ability to do research and to train and educate rural law-enforcement officers in forensics," Fitzgerald adds.

Other MFRC research efforts have included projects to restore obliterated serial numbers from steels, aluminum

and other metals, and to determine bomb-blast effects upon metals. "As far as new research efforts, we'd expect to fund proposals that support ongoing or existing types of analyses, such as the development of new instrumentation or new methodologies to support crime labs," says Baldwin. He'd also like to see research proposals that support the use of statistical analysis of classes of evidence. Baldwin says investigators can already determine the probability that a human sample matches the DNA of a suspect and the degree of confidence or the significance of that finding. Now he says similar statistical methods need to be developed for analyses to do the same type of matching with bullets, glass and steel. "This is a hot issue right now because of the way DNA has revolutionized the way courts use forensic evidence," says Baldwin.

Research and development assistance to improve forensic capabilities is just one part of the MFRC's four-part mission. Other focuses include casework assistance for crime labs, educating the next generation of forensic scientists and providing forensic training assistance for crime-lab scientists and law-enforcement professionals. In the area of casework assistance, the MFRC is building upon the bioterrorism database idea by developing a database of forensic resources expertise for criminalists. This expertise, for example, would allow a criminalist in the Midwest to find and then consult with technical experts at the Laboratory on a range of topics, such as materials identification.

In addition to casework, the MFRC's training program is also receiving high-level interest. The FBI's Forensic Science Training Unit is considering making the MFRC part of its "virtual" training academy system. In the past, the FBI has provided training solely at its academy in Quantico, Va., but the agency has a limited number of trainers and space so it wants to access the resources of strategic partners nationwide who are qualified to teach training courses in forensics. "This approach fits exactly into the type of training we are equipped to deliver," says Baldwin, who adds the MFRC is hoping to use the capabilities of ISU's Instructional Technology Center to facilitate its training mission.

Ames Laboratory's Todd Zdorkowski (left) and David Baldwin confer with Jane Homeyer, director of the Forensic Science Training Unit at the FBI Academy, at the 2002 MFRC annual meeting. Homeyer urged the MFRC to consider becoming one of the FBI's training partners.

Now that the groundwork has been laid, the next several months will bring a second flurry of activity as efforts are made to enhance all four of the MFRC's mission areas. Those efforts will range from funding more research proposals to fostering more university/crime lab interactions to expanding training programs for forensic scientists to increasing casework assistance. As evidence of this commitment, the MFRC has already begun offering up to 40 hours of casework assistance for criminologists wanting to consult with any of Ames Lab's technical experts. A confident Baldwin believes he'll be able to find the support to help foster all of the MFRC's goals. "Sometimes you work on research in a bureaucracy, and everyone is arguing about what's important," Baldwin says. But that's not the case with the MFRC, he adds. "Everyone is seeing universal importance in everything we're talking about doing."

Biorenewable Resources Consortium

It's no secret that the world, and industry in particular, has a huge appetite for oil and natural gas as energy sources. It's also no secret that at the current rate of consumption these traditional energy supplies will eventually be depleted. The goal of the Biorenewable Resources Consortium, or BRC, is to lessen our nation's dependence on fossil resources and petrochemicals as energy sources by developing agricultural alternatives, such as plant matter, or biomass, to create products and energy. Accomplishing this goal would help improve U.S. competitiveness internationally, provide greater crop diversity for farmers, reduce carbon dioxide emissions from the use of conventional fossil fuels, help form new industries, and enhance economic development in rural states like Iowa.

Ames Laboratory is uniquely positioned to play a key role in the development and use of biorenewable resources as a sustained supply of energy due to its location in the heart of the agricultural belt, which provides access to an unlimited supply of biorenewable resources as well as the ability to access the world's most advanced crop research through ISU. By combining its research strengths with those of its partners, ISU's Plant Sciences Initiative and the USDA's Iowa Agriculture and Home Economics Experiment Station, the Lab hopes to take a leadership role in making biorenewable energy a cost-effective, environmentally safe source for energy and chemical products.

Congressman Tom Latham announced $2 million in federal funding for the BRC in January 2002. Since the announcement, George Kraus, chair of the BRC task force and an ISU chemistry professor, says the BRC has moved quickly to issue a request for proposals for research projects from Ames Laboratory and ISU scientists. Nineteen proposals have been received. Eleven of those were chosen to receive on average $80,000 each. "The proposals are

broad-based, ranging from research on issues of fermentation to composites to catalytic reactions," says Kraus. "We believe that a lot of interesting science will emerge."

A key requirement of the BRC research proposals is that they are collaborative in nature, meaning they include interactions between scientists from various disciplines. The goal of this cross-boundary interaction is to develop what Kraus calls "interfacial science."

"We want to bring people together who really haven't interacted with one another much," says Kraus. "Whenever you bring people together from different areas you almost always get different perspectives and, hence, new ideas and strategies for solving problems." Kraus adds the perfect research scenario might include engineers interacting with chemists, who are interacting with food scientists, who are interacting with people from forestry. "There are some pretty ingenious proposals being funded," says Kraus. "I just can't wait to see how some of them actually pan out when we try the science."

Brent Shanks, an ISU associate professor of Chemical Engineering, is one of the scientists whose research proposal has received a grant from the BRC. Shanks proposes taking a biorenewable resource, such as soybean oil, and producing dibasic acids by cleaving, or splitting, the fatty acids contained within. These dibasic acids could be used to replace adipic acid, which is a basic ingredient used in the production of nylon. Nylon is used extensively in carpeting and other products. Industry produces over a billion pounds of adipic acid each year, all of which is produced from fossil fuels. Shanks wants to determine if the adipic acid replacement can be produced from biological sources rather than fossil fuels. "There's a great opportunity before us to get rid of this fossil-fuel-derived material in favor of one that's soybean-oil-derived," says Shanks, who adds that dibasic acids produced from biorenewable materials also have the potential to be cheaper to manufacture than adipic acid made from fossil fuels. It potentially could cost on the order of 40 cents per pound to produce dibasic acids from soybean oil, whereas adipic acid costs around 60 cents per pound to manufacture from fossil fuels. "So not only is there the potential to get rid of a fossil-fuel-derived material, but also an opportunity to provide better economics for industry with soybean-oil-derived material," Shanks says.

Brent Shanks draws a sample of the conversion product from a batch reactor. This sample will be analyzed for yield of the desired dibasic acid product.

An enthusiastic Shanks says he's anxious to get started on his research project and readily admits that without the BRC funding his project might have been a long time in coming. "This BRC seed money will allow us the chance to actually validate that we can do this conversion," says Shanks, who adds that this is very important in a scientific world where funding is often based on results rather than promises of what could occur. At the same time, Shanks is also looking forward to the interactions he'll have with scientists elsewhere at Ames Laboratory and ISU who have backgrounds dissimilar to his. In his research project, Shanks will combine his expertise in chemical engineering with those of scientists whose backgrounds are in catalytic conversion of biological feedstocks, advanced catalytic materials, and oxidation chemistry. "The interplay of this experience will be needed to successfully complete the proposed work," says Shanks.

As for the future of the BRC and of biorenewables research at Ames Lab and ISU, Kraus says it's all in the numbers – numbers of scientists that is. There simply needs to be more researchers working in the biorenewables area, says Kraus. "I think we're primed to do great things, but we don't have all the researchers we need to cover all our bases in biorenewables," he says. "Ames Lab and ISU have a ways to go to catch up to other universities that have a much stronger tradition in biorenewables." But he adds, "We're off to a pretty fast start."

Green Chemistry Catalysis Laboratory

At the same time the MFRC and BRC were receiving funding so was the initiative to establish the Green Chemistry Catalysis Laboratory, or GCCL, at Ames Laboratory and the Center for Catalysis at ISU. Senator Tom Harkin announced $500,000 in funding for catalysis research at ISU.

In order to understand the significance of catalysis research to Iowa, one must first understand catalysis itself and its connection to "green" chemistry. *Webster's New World College Dictionary* defines catalysis as "the speeding up or, sometimes, slowing down of the rate of a chemical reaction caused by the addition of some substance that does not undergo a permanent chemical change." This phenomenon is used widely in the pharmaceutical, chemical and energy industries to manufacture all sorts of products, from pharmaceuticals to cosmetics to cleaner fuels.

Unfortunately, many of the catalytic reactions used in industry to create these products generate large volumes of hazardous pollutants, which is where green chemistry comes into play. Green chemistry refers to chemical processes that do not harm the environment. These processes often occur at room temperatures and ordinary pressures, and use water, preferably, as a solvent. They require the expenditure of less energy, occur much more rapidly and produce significantly fewer unwanted byproducts than competing industrial processes.

According to Kraus, who also directs the GCCL for Ames Lab, Iowa is in a strong position to capitalize on the growing relationship between environmentally friendly catalysts and biorenewable resources. For example, Kraus says there has been a lot of talk about taking ordinary field crops, such as corn and soybeans, and converting them into value-added products. At almost every step of this process, Kraus explains, a catalytic conversion would be required.

A goal of the catalysis laboratory would be to discover new catalysts and chemical reactions that operate in an environmentally friendly manner, which would help the nation replace fossil-fuel-based feedstocks with those based on renewable resources, thus ensuring an adequate energy supply for generations to come. One example of this relationship would be the creation of new environmentally friendly catalysts to convert soybean oil into biodiesel fuel. Another would be biocatalysts to synthesize fine chemicals for pharmaceuticals. Still another would be new catalysts for compounds used in flavorings and fragrances. "We hope some of the catalysts developed in our green chemistry lab and catalysis center will accelerate the process of developing these bio-efforts across Iowa," says Kraus. "Our ultimate goal is to unearth some new science and develop some catalysts that could help create new markets for Iowa products, thereby enhancing Iowa's rural development," he adds.

"Our work could potentially lead to the creation of new industry in Iowa," says Andreja Bakac, Ames Laboratory senior chemist, whose project has received funding through the GCCL. Bakac will use the $50,000 grant to further her work to develop a heterogeneous catalytic system for the oxidation of hydrocarbons. Benzene is an example of a hydrocarbon that she can currently oxidize in a homogeneous solution. The reaction uses visible light as an energy source and oxygen as oxidant, but the homogeneous setup does not allow for easy removal or regeneration of the catalyst after the completion of the reaction. Rather, the catalyst is wasted and must be disposed of, which increases the cost of the process. This problem will be solved if the transfer to a heterogeneous system is successful. "If we can develop this new system and get industry interested in it, perhaps that industry would locate in Iowa," says Bakac, who adds that the timing for the GCCL funding is just perfect. "Without this funding this project would be sitting on a back burner waiting for other money to come in, if and when."

Like the BRC, the GCCL initiative hopes to bring together "teams" of scientists to work on solving mutual problems. David Hoffman, division director of Science and Technology at Ames Laboratory and an ISU professor of chemistry,

Andreja Bakac observes photolysis (chemical decomposition induced by light) in a reaction solution as part of a catalysis experiment.

believes the potential exists for establishing numerous new cutting-edge research teams in catalysis at Ames Lab and ISU. For example, Hoffman envisions research teams consisting of chemists, biochemists, materials scientists and engineers as well as mathematicians. He adds that many of these researchers will have already made individual strides in catalysis research. Creating, fostering and nurturing a synergy between these individuals is a new challenge he expects will quickly take root.

"We have already formed our team and we're working together," says Bakac, whose research project is a perfect example of the synergy of which Hoffman speaks. Bakac is combining her expertise with that of three other Ames Lab and ISU scientists – Marek Pruski, Victor Lin and Brent Shanks – to complete her research project. "We need each other to make this work," says Bakac, who, like Hoffman, believes the team approach is not only good for the research but also for the researchers. Hoffman adds, "We're off to a very smooth start." ♦

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